Fault displacement and fold contraction estimated by unfolding of Quaternary strata, onshore and offshore Ventura basin, California

USDI/USGS 1434-HQ97-GR-03085

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NEHRP Element: I Keywords: Structural Geology, Reflection Seismology; Active Faulting

Research supported by the U. S. Geological Survey (USGS), Department of the Interior, under USGS award number 1434-HQ97-GR-03085 The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U. S. Government.

ABSTRACT

This project uses the program UNFOLD to restore digital subsurface maps of onshore and offshore Ventura basin and the Oak Ridge fault to an initial horizontal state. Digital maps have been created, and 3-D views of a deformed surface created. The unfolded surfaces in each fault and fold block were fit together and compared to the present deformed state to result in a model for horizontal displacement.

The Oak Ridge fault of southern California has been interpreted either as an active fault that cuts to earthquake-source depths onshore and offshore, or alternatively as only a shallow fault onshore, and an axial surface of a fold, not a fault, offshore. We mapped the geometry of a 1.8 Ma layer, mapped the offshore part of a 1 Ma layer and used an existing onshore map, and digitized and restored the folded 1 Ma layer to an initial horizontal state. The S-dipping Oak Ridge fault is very arcuate, with sharp bends in strike between an E-W segment near Santa Paula, a NE-SW coastal segment, and a WNW-ESE offshore segment along the Mid Channel trend. N-S shortening across the E-W onshore Oak Ridge fault limits left slip on the NE-SW Santa Paula segment to about 1.5 km, unless left-lateral slip is transferred across Ventura basin from the San Cayetano and related faults. Without this inferred connecting or "tear" fault, the rate of post-1 Ma slip on the deep, blind, offshore Oak Ridge fault must be less than 2.6 mm/yr, with only a small fraction of a mm/yr absorbed across that fault. Transfer of slip on the deep offshore Oak Ridge fault north to folds along the northern margin of Ventura basin must be less than half the previously-proposed 5 mm/yr. Our alternative reconstruction transfers 2 km of left slip across onshore Ventura basin, most of which is seen as left slip along, not shortening across, the offshore Oak Ridge fault. In either reconstruction, onshore slip is kinematically-linked to offshore slip and the offshore structure is a fault.

There is therefore no direct evidence offshore for a previously proposed abrupt change in fault kinematics at 0.5 Ma. Vertical rates of motion due to faulting and folding are approximately the same across the offshore fault since 1 Ma, 200 ka, and